

CLAIMS

1. An engine cranking system comprising:
 - an engine operably moveable between a running condition and an off condition;
 - 5 a cranking motor coupled to said engine;
 - a battery comprising first and second battery terminals, said first battery terminal electrically coupled to said cranking motor and said second battery terminal electrically coupled to a system ground;
 - a capacitor comprising first and second capacitor terminals;
 - 10 first and second electrical paths interconnecting said first and second capacitor terminals, respectively, with said cranking motor and said system ground;
 - an ignition switch coupled between said first battery terminal and said cranking motor, said ignition switch completing an electrical path
 - 15 between said first battery terminal and said cranking motor when moved to a start position;
 - a first relay connected between the cranking motor and said system ground, said first relay comprising a first switched terminal and a second switched terminal, said first relay comprising a switch moveable
 - 20 between a first position and a second position in response to a first control voltage being applied thereto by said battery when said ignition switch is moved to said start position, wherein said first and second switched terminals are electrically connected when said first relay is moved to said second position;
 - 25 a second relay included in one of said first and second electrical paths and having a first control terminal and a second control terminal, wherein said second relay is moveable between at least an open-circuit condition and a closed-circuit position in response to a second control voltage being applied thereto across said first and second control terminals, wherein
 - 30 said second relay interrupts said one of said first and second electrical paths when in said open-circuit position, and wherein said second relay completes

said one of said first and second electrical paths when in said closed-circuit position; and

wherein one of said first and second switched terminals of said first relay is coupled to one of said first and second capacitor terminals, wherein the other of said first and second switched terminals of said first relay is coupled to one of said first and second control terminals of said second relay, and wherein the other of said first and second capacitor terminals is coupled to the other of said first and second control terminals of said second relay.

2. The engine cranking system of claim 1 wherein said second switched terminal of said first relay is coupled to said second capacitor terminal, wherein said first switched terminal of said first relay is coupled to said second control terminal of said second relay, and wherein said first capacitor terminal is coupled to said first control terminal of said second relay.

3. The engine cranking system of claim 2 wherein said second relay is included in said second electrical path.

4. The engine cranking system of claims 1 or 2 wherein said first relay comprises a third switched terminal, and wherein said first and third switched terminals are electrically connected and said first and second switched terminals are electrically disconnected when said first relay is in said first position.

5. The engine cranking system of claim 4 wherein said relay is moved to said first position in response to the ignition switch being disengaged from the start position.

6. The engine cranking system of claim 4 further comprising a running engine sensory component coupled between said third switched terminal of said first relay and said system ground, wherein said running engine sensory component completes the electrical path between said third

switched terminal and said system ground and thereby maintains said second relay in said closed-circuit position when said engine is operated in said running condition.

5 7. The engine cranking system of claim 6 wherein said running engine sensory component comprises a normally open oil pressure switch, wherein said normally open oil pressure switch is positionable in a closed position in response to at least a predetermined minimum oil pressure being applied thereto.

10 8. The engine cranking system of claim 7 wherein said predetermined minimum pressure is greater than or equal to about 5 psi.

15 9. The engine cranking system of claim 6 further comprising a momentary switch electrically coupled between said second capacitor terminal and said second control terminal of said second relay, said momentary switch moveable between an open position and a closed position, wherein said momentary switch completes the electrical path between said second capacitor terminal and said second control terminal of said second relay when in said closed position.

20 10. The engine cranking system of claim 1 wherein said capacitor comprises a double layer capacitor characterized by a capacitance greater than about 150 farads and an internal resistance at 20°C less than about 0.008 ohms.

25 11. The engine cranking system of claim 1 further comprising a momentary switch electrically coupled between one of said first and second capacitor terminals and one of said first and second control terminals of said second relay, said momentary switch moveable between an open position and a closed position, wherein said momentary switch completes the electrical path between said one of said first and second capacitor terminals and said one of said first and second control terminals of said second relay when in said closed position.

12 . An engine cranking system comprising:

an engine operably moveable between a running condition and an off condition;

a cranking motor coupled to said engine;

5 a battery comprising first and second battery terminals, said first battery terminal electrically coupled to said cranking motor and said second battery terminal electrically coupled to a system ground;

a capacitor comprising first and second capacitor terminals;

10 first and second electrical paths interconnecting said first and second capacitor terminals, respectively, with said cranking motor and said system ground;

15 an ignition switch coupled between said first battery terminal and said cranking motor, said ignition switch completing an electrical path between said first battery terminal and said cranking motor when moved to a start position;

20 a first relay connected between the cranking motor and said systems ground, said first relay comprising a first switched terminal, a second switched terminal and a third switched terminal, said first relay comprising a switch moveable between a first position and a second position in response to a first control voltage being applied thereto by said battery when said ignition switch is moved to said start position, wherein said first and second switched terminals are electrically connected when said first relay is moved to said second position and wherein said first and third switched terminals are electrically connected when said first relay is in said first position;

25 a second relay included in said second electrical path and having a first control terminal and a second control terminal, wherein said second relay is moveable between at least an open-circuit condition and a closed-circuit position in response to a second control voltage being applied thereto across said first and second control terminals, wherein said second relay interrupts said second electrical path when in said open-circuit position, and wherein said second relay completes said second electrical path when in said closed-circuit position;

30

a running engine sensory component coupled between said third switched terminal of said first relay and said system ground, wherein said running engine sensory component completes the electrical path between said third switched terminal and said system ground and thereby maintains said second relay in said closed-circuit position when said engine is operated in said running condition;

a momentary switch electrically coupled between said second capacitor terminal and said second control terminal of said second relay, said momentary switch moveable between an open position and a closed position, wherein said momentary switch completes the electrical path between said second capacitor terminal and said second control terminal of said second relay when in said closed position; and

wherein said second switched terminal of said first relay is coupled with said second capacitor terminal, wherein said first switched terminal of said first relay is coupled to said second control terminal of said second relay, and wherein said first capacitor terminal is coupled to said first control terminal of said second relay.

13. The engine cranking system of claim 12 wherein said running engine sensory component comprises a normally open oil pressure switch, wherein said normally open oil pressure switch is positionable in a closed position in response to at least a predetermined minimum oil pressure being applied thereto.

14. An engine cranking system comprising:
an engine operably moveable between a running condition and an off condition;
a cranking motor coupled to said engine;
a battery comprising first and second battery terminals, said first battery terminal electrically coupled to said cranking motor and said second battery terminal electrically coupled to a system ground;
a capacitor comprising first and second capacitor terminals;

first and second electrical paths interconnecting said first and second capacitor terminals, respectively, with said cranking motor and said system ground;

an ignition switch coupled between said first battery terminal and said cranking motor, said ignition switch completing an electrical path between said first battery terminal and said cranking motor when moved to a start position;

a running engine sensory component comprising a first switched terminal, a second switched terminal and a third switched terminal, said running engine sensory component comprising a switch moveable from a first position to a second position when said engine is operated in said running condition, wherein said first and third switched terminals are electrically coupled when said switch is in said first position, and wherein said first and second switched terminals are electrically coupled when said switch is in said second position;

a relay included in one of said first and second electrical paths and having a first control terminal and a second control terminal, wherein said second relay is moveable between at least an open-circuit condition and a closed-circuit position in response to a control voltage being applied thereto across said first and second control terminals, wherein said relay interrupts said one of said first and second electrical paths when in said open-circuit position, and wherein said relay completes said one of said first and second electrical paths when in said closed-circuit position; and

a control module electrically coupled to each of said first and second control terminals of said relay, wherein said control module is electrically coupled to at least one of said first and second capacitor terminals, wherein said control module is operable to measure a voltage applied by said battery when said ignition switch is in the start position and said switch of said running engine sensory component is in said first position and to electrically couple said capacitor with said relay if said voltage is greater than or equal to a minimum predetermined voltage, and wherein said control module is operable to electrically couple at least one of said capacitor and said battery

with said relay when said switch of said running engine sensory component is in said second position.

5 15. The engine cranking system of claim 14 wherein said battery and said capacitor are electrically coupled in parallel with said relay when said switch of said running engine sensory component is in said second position.

10 16. The engine cranking system of claim 14 wherein said control module is operable to electrically couple said second control terminal of said relay with second capacitor terminal if said voltage is greater than or equal to said minimum predetermined voltage, and wherein said control module is operable to maintain the electrical coupling between said second control terminal of said relay with said second capacitor terminal when said switch of said running engine sensory component is in said second position.

15 17. The engine cranking system of claim 16 wherein said relay is included in said second electrical path.

20 18. The engine cranking system of claim 14 wherein said running engine sensory component comprises an oil pressure switch, wherein said oil pressure switch is positionable in said second position in response to at least a predetermined minimum oil pressure being applied thereto.

 19. The engine cranking system of claim 18 wherein said predetermined minimum pressure is greater than or equal to about 5 psi.

25 20. The engine cranking system of claim 14 further comprising a momentary switch electrically coupled between one of said first and second capacitor terminals and one of said first and second control terminals of said relay, said momentary switch moveable between an open position and a closed position, wherein said momentary switch completes the electrical path between said one of said first and second capacitor terminals and said one of

said first and second control terminals of said relay when in said closed position.

21. The engine cranking system of claim 20 wherein said momentary switch is electrically coupled between said second capacitor terminal and said second control terminal of said relay.

22. The engine cranking system of claim 14 wherein said capacitor comprises a double layer capacitor characterized by a capacitance greater than about 150 farads and an internal resistance at 20°C less than about 0.008 ohms.

23. The engine cranking system of claim 14 wherein said first switched terminal of said running engine sensory component is electrically coupled to said first control terminal of said relay and wherein said control module is electrically coupled to said second capacitor terminal, and wherein said first terminal of said capacitor is electrically coupled to said first control terminal of said relay through said first battery terminal, said ignition switch and said third and first switched terminals of said running engine sensory component when said running engine sensory component is in said first position.

24. The engine cranking system of claim 14 wherein said first capacitor terminal is electrically coupled to said second switched terminal of said running engine sensory component.